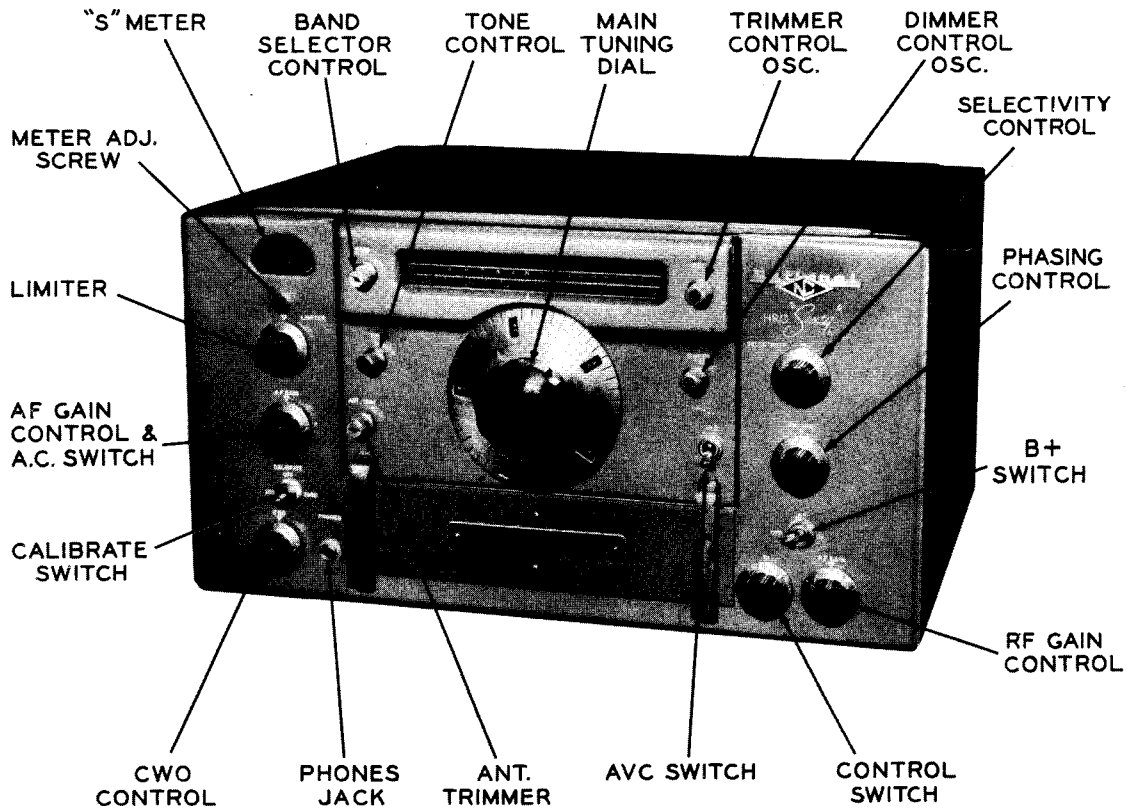




NATIONAL
MODEL HRO-60



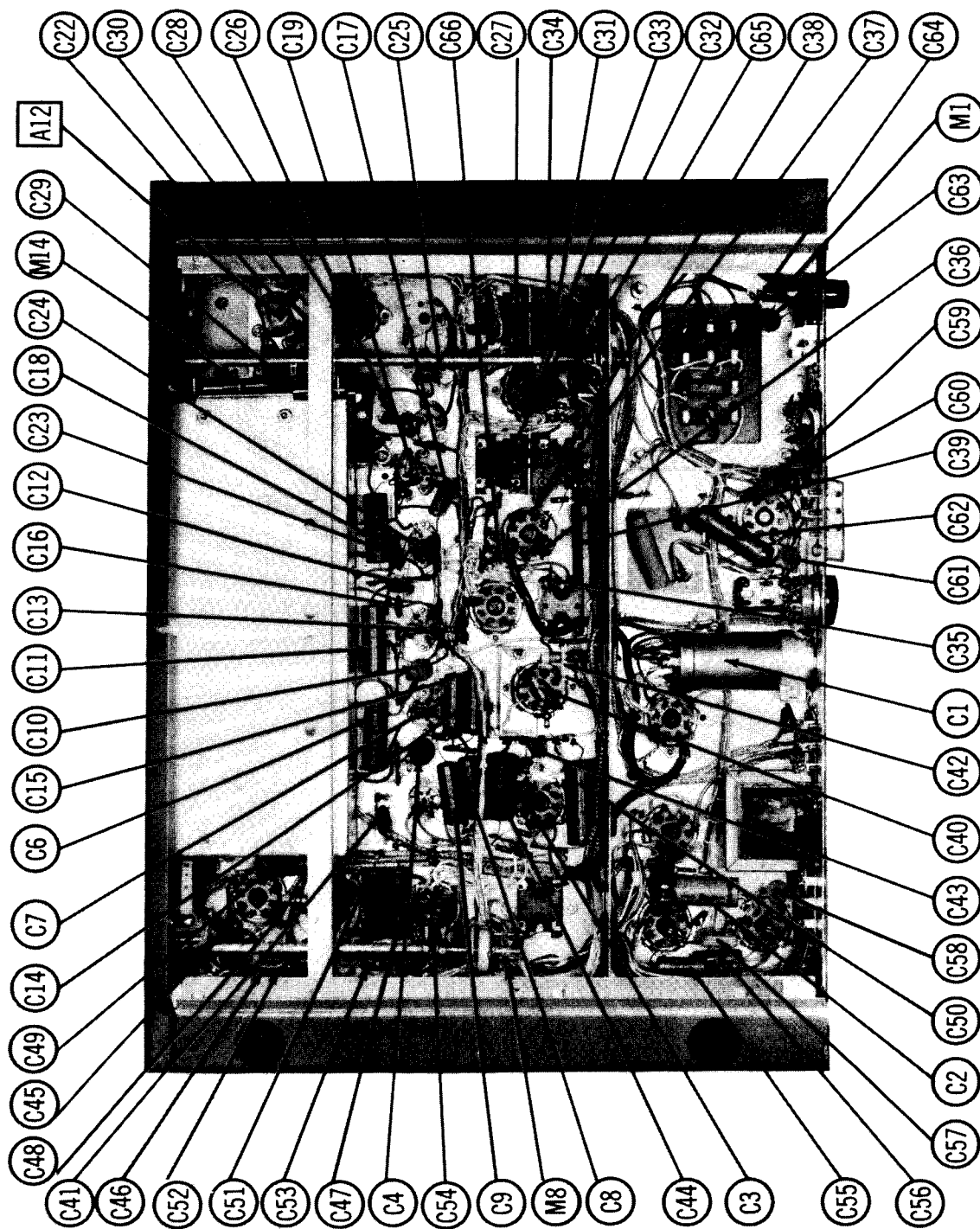
NATIONAL
MODEL HRO-60

TRADE NAME	National Model HRO-60		
MANUFACTURER	National Co., Inc., 61 Sherman St., Malden 48, Mass.		
TYPE SET	AC Operated Multi-Band AM Superheterodyne Communications Receiver		
TUBES	Eighteen		
POWER SUPPLY	110-120 Volts AC	RATING	1.0 Amp@ 117 Volts AC
TUNING RANGES	Coil Set	General Coverage	Bandspread
	A	14-30MC	27.0-30.0MC
	B	7-14.4MC	14.0-14.4MC
	C	3.5-7.3MC	7.0-7.3MC
	D	1.7-4.0MC	3.5-4.0MC
	E	900-2050KC	
	F	480-960KC	
	G	180-430KC	
	H	100-200KC	
	J	50-100KC	
	AA		27.5-30MC
	AB	25.35MC	
	AC		21.0-21.5MC
	AD		50-54MC

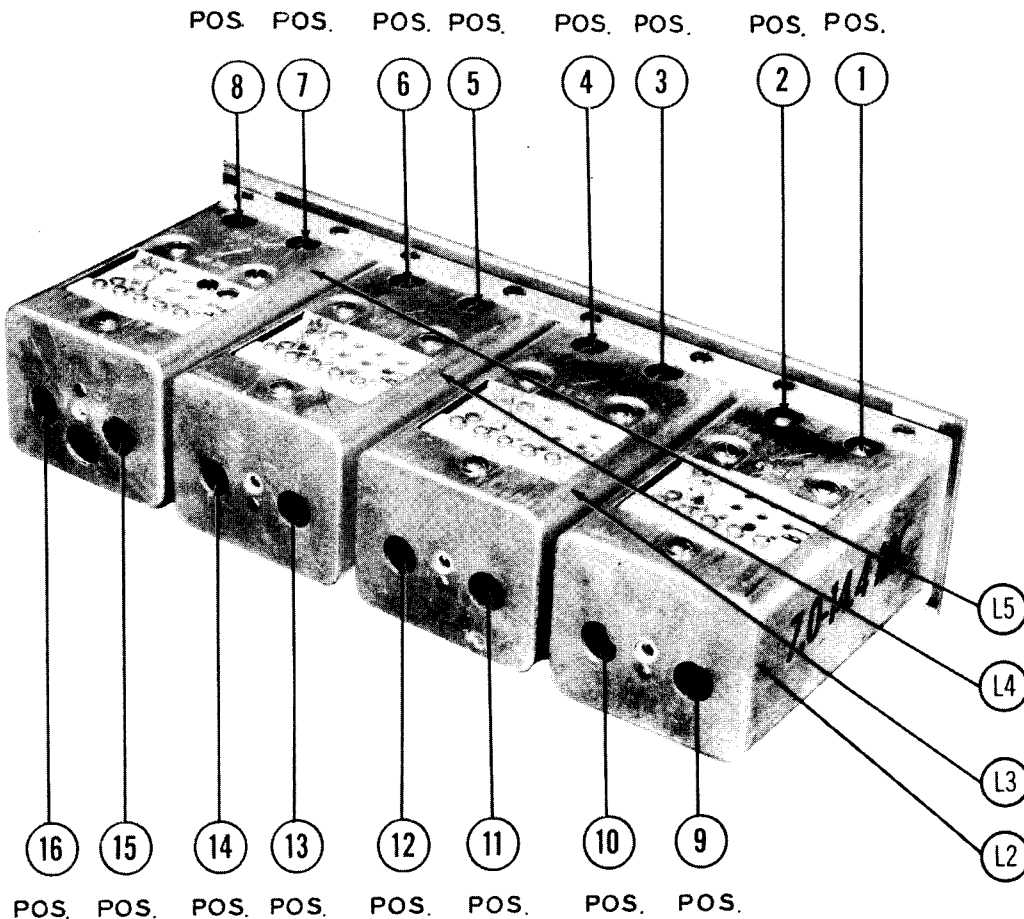
HOWARD W. SAMS & CO., INC. • Indianapolis 5, Indiana

"The listing of any available replacement part herein does not constitute in any case a recommendation, warranty or guaranty by Howard W. Sams & Co., Inc., as to the quality and suitability of such replacement part. The numbers of these parts have been compiled from information furnished to Howard W. Sams & Co., Inc., by the manufacturers of the particular type of replacement part listed."
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CHASSIS BOTTOM VIEW-CAPACITOR IDENTIFICATION

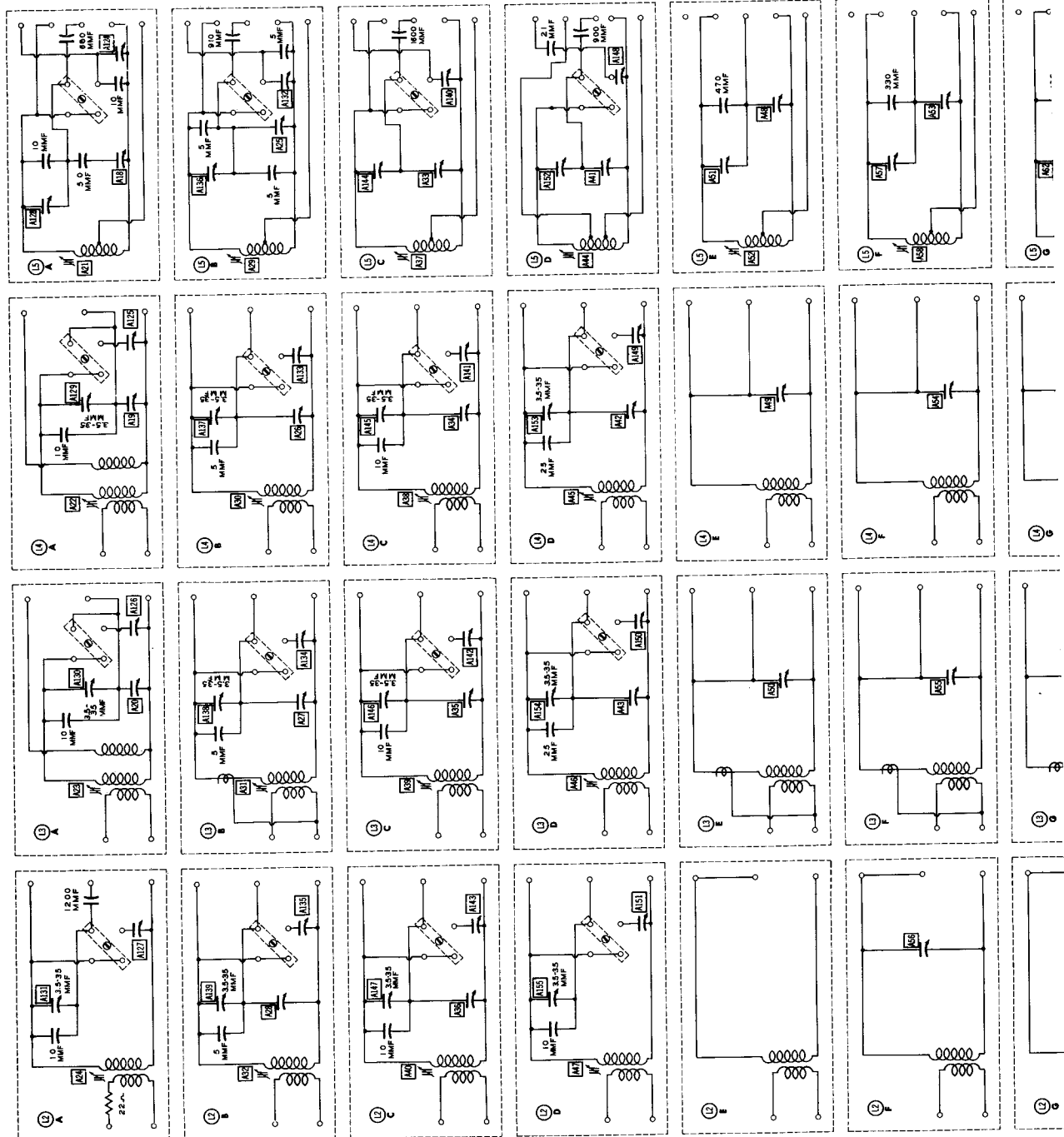


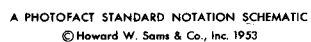
PLUG-IN COIL SET

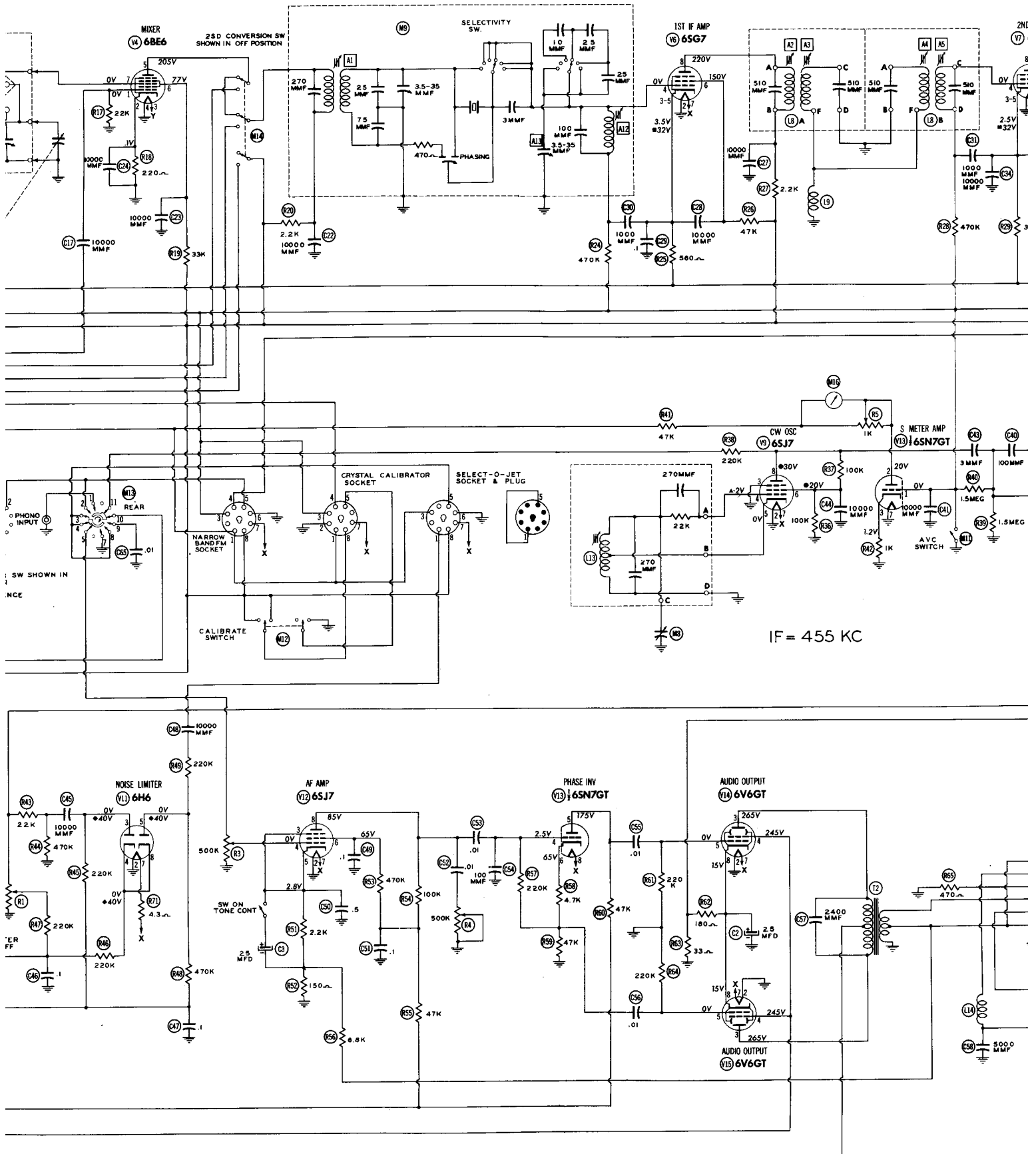
NOTE: INDUCTANCE ADJUSTMENTS AT POSITION NO. 16 ARE AS FOLLOWS:

1. A, B & C Coil Sets --- Loop of wire inside coil form -- bending the loop one way or the other adds or subtracts to the inductance.
2. D Coil Set --- Adjustable disc inside coil form --- moving the disc toward the center of the coil decreases inductance.
3. E, F, G, H & J Coil Sets --- A short-circuited turn of wire around the outside of the coil --- moving this turn up or down varies the inductance.

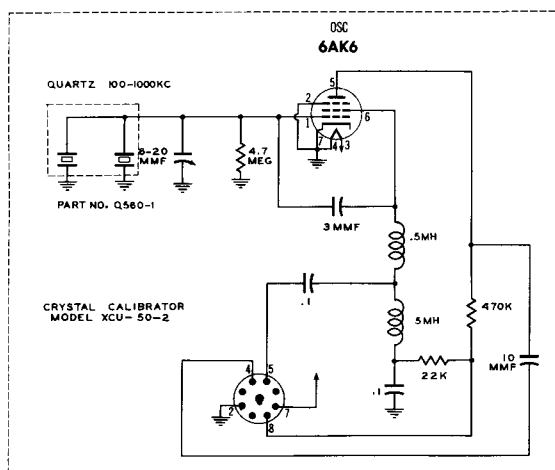
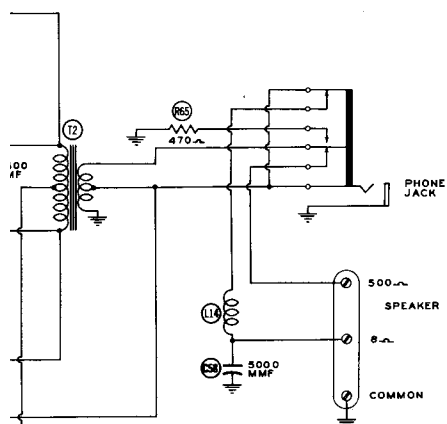
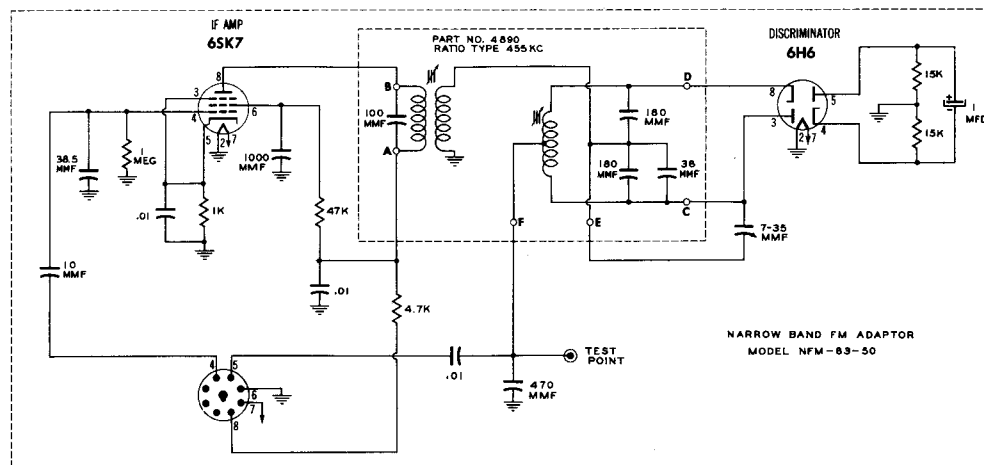
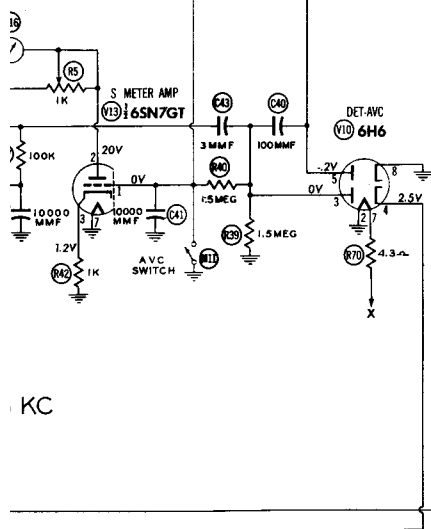
Inductance adjustment at position Nos. 9, 11 & 13 of coil sets A, B, C, D, AA, AB, AC & AD is a loop of wire inside coil form --- bending the loop one way or the other varies the inductance.



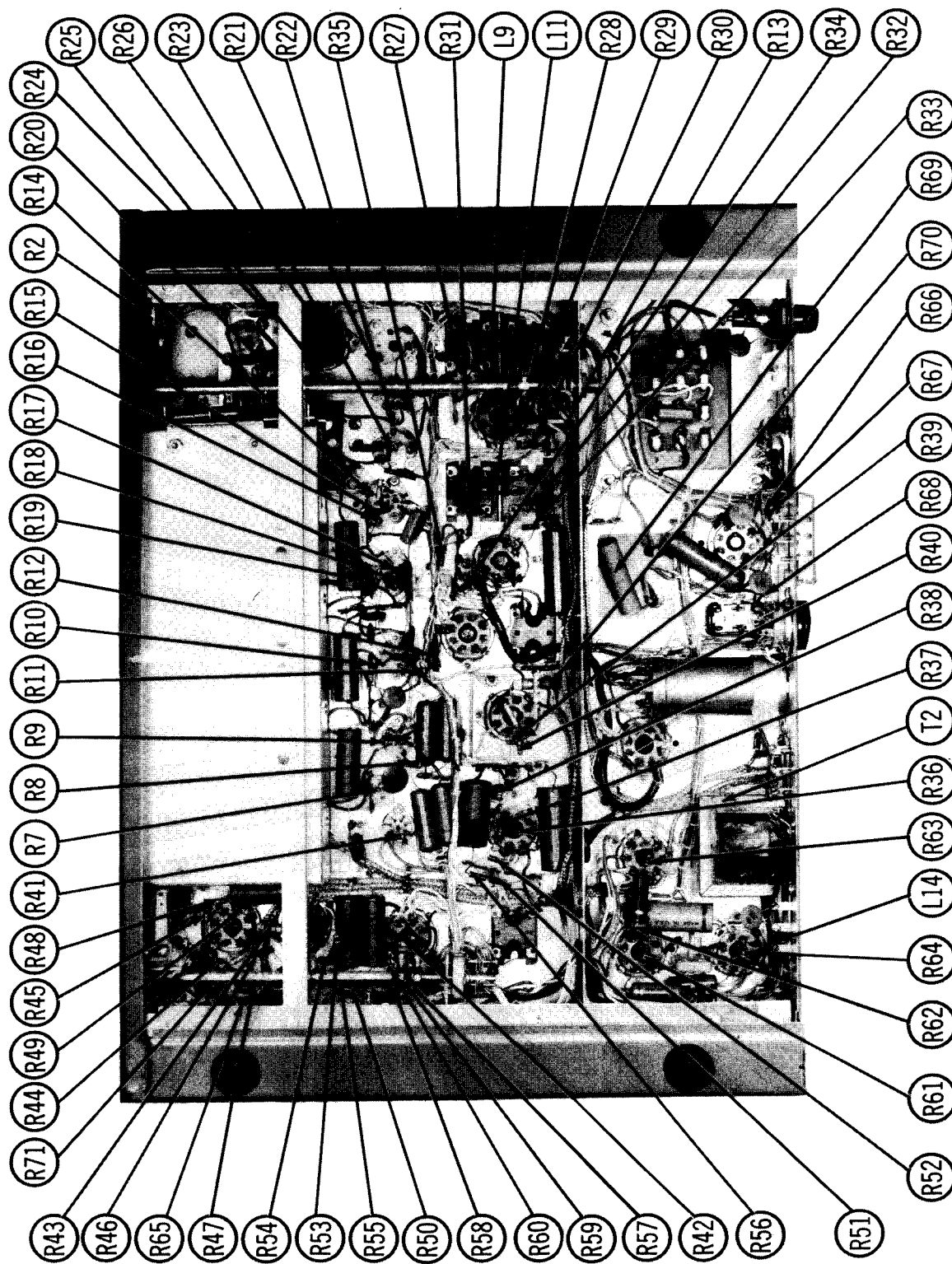




IF = 455 KC

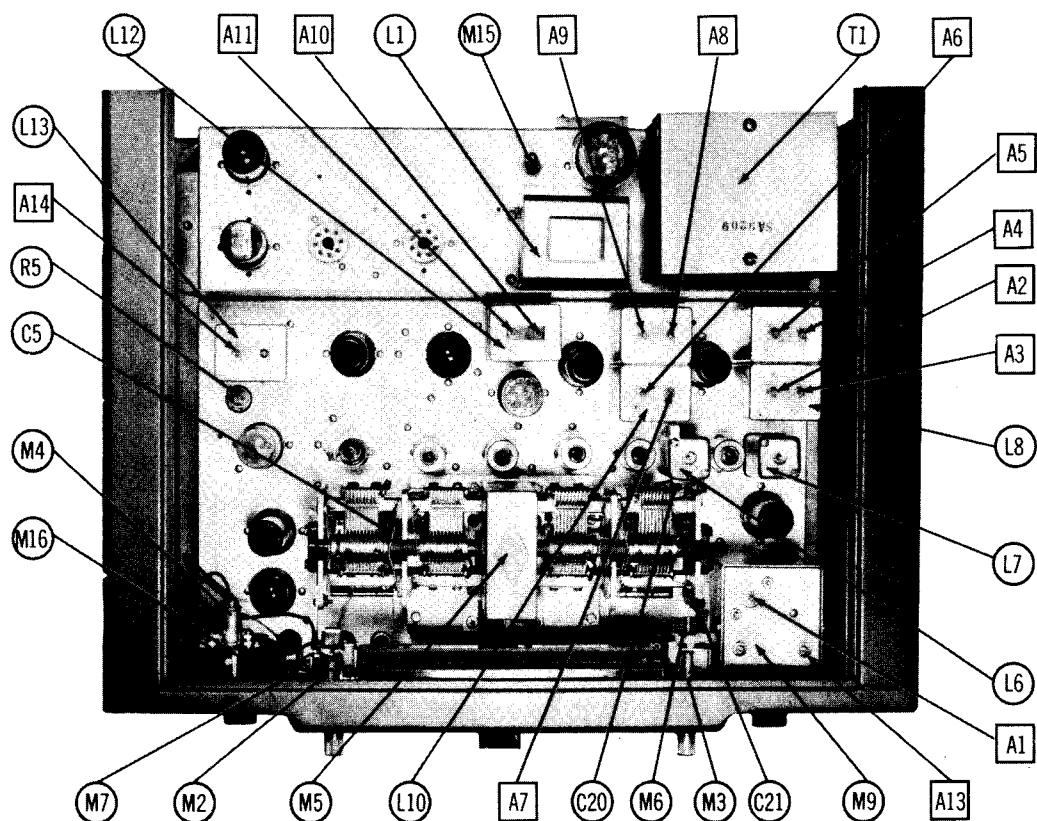


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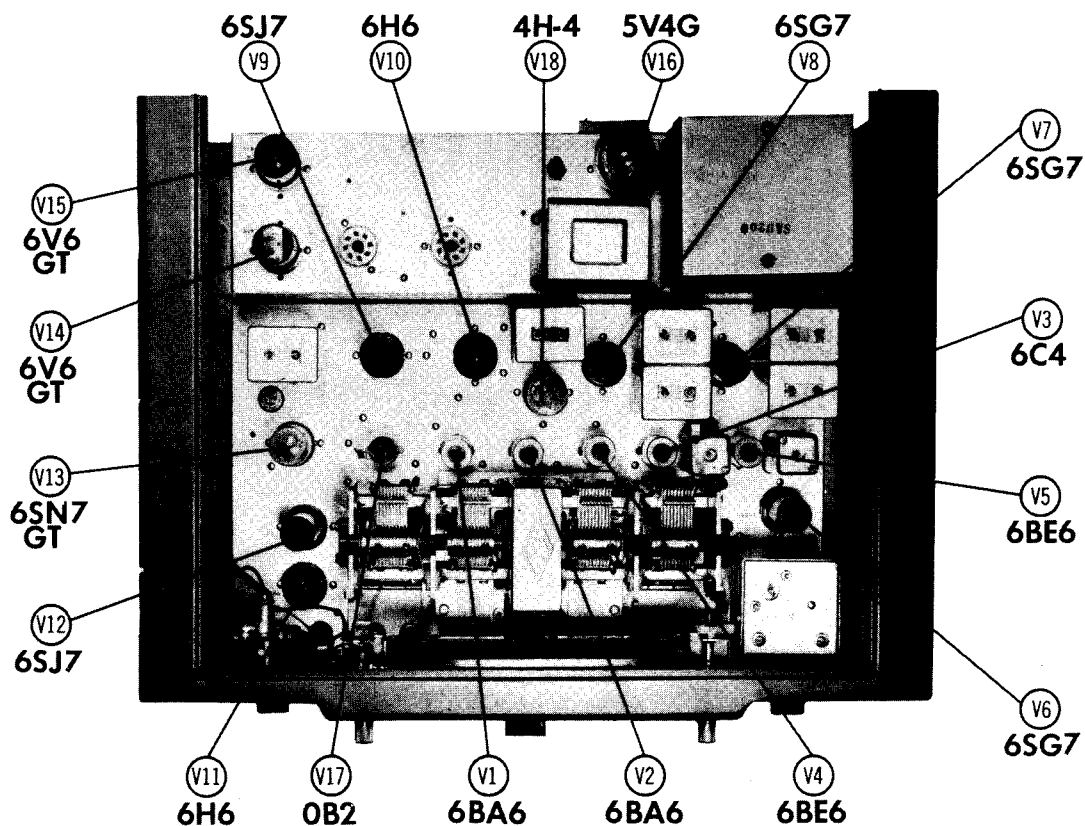


CHASSIS BOTTOM VIEW - RESISTOR IDENTIFICATION

NATIONAL
MODEL HRO-60



CHASSIS TOP VIEW



CHASSIS TOP VIEW

ARTS LIST AND DESCRIPTIONS (Continued)

COILS OF -IF JOURNAL

ITEM No.	USE	DC RES.		REPLACEMENT DATA			NATIONAL PART No.	MILLER PART No.	MEISSNER PART No.	IRC PART No.	NOTES
		PRI.	SEC.	SA: 6751	SA: 6752	SA: 6753					
L3A	1st.RF Trans.	.70	00	SA: 6751							A Band, 14-30MC, tertiary winding-8.52
B	1st.RF Trans.	4.80	.10	SA: 9258							B Band, 7-14.4MC
C	1st.RF Trans.	9.20	.22	SA: 6841							C Band, 3.5-7.3MC
D	1st.RF Trans.	230	.72	SA: 6837							D Band, 1.7-4MC
E	1st.RF Trans.			SA: 6840							E Band, 900-2050KC
F	1st.RF Trans.			SA: 6862							F Band, 480-960KC
G	1st.RF Trans.			SA: 6867							G Band, 180-420KC
H	1st.RF Trans.			SA: 6869							H Band, 100-200KC
I	1st.RF Trans.			SA: 6871							I Band, 50-100KC
J	1st.RF Trans.			SA: 6872							AA Band, 27-30MC
K	1st.RF Trans.			SA: 6818							AB Band, 25-35MC
L	1st.RF Trans.			SA: 8074							AC Band, 21-21.5MC
M	1st.RF Trans.			SA: 9262							AD Band, 50-54MC
L4	2nd.RF Trans.	.70	00	SA: 6752							A Band, 14-30MC, tertiary winding-8.52
B	2nd.RF Trans.	.20	.10	SA: 9259							B Band, 7-14.4MC
C	2nd.RF Trans.	9.50	.20	SA: 6642							C Band, 3.5-7.3MC
D	2nd.RF Trans.	230	.70	SA: 6638							D Band, 1.7-4MC
E	2nd.RF Trans.			SA: 6789							E Band, 900-2050KC
F	2nd.RF Trans.			SA: 6794							F Band, 480-960KC
G	2nd.RF Trans.			SA: 6800							G Band, 180-420KC
H	2nd.RF Trans.			SA: 6804							H Band, 100-200KC
I	2nd.RF Trans.			SA: 6810							I Band, 50-100KC
J	2nd.RF Trans.			SA: 9248							AA Band, 27-30MC
K	2nd.RF Trans.			SA: 6876							AB Band, 25-35MC
L	2nd.RF Trans.			SA: 8075							AC Band, 21-21.5MC
M	2nd.RF Trans.			SA: 9266							AD Band, 50-54MC
L5A	HF Osc. Coil	00		SA: 9254							A Band, 14-30MC, tapped
B	HF Osc. Coil	.10		SA: 9260							B Band, 7-14.4MC, tapped
C	HF Osc. Coil	.20		SA: 6780							C Band, 3.5-7.3MC, tapped
D	HF Osc. Coil	.70		SA: 6876							D Band, 1.7-4MC, tapped
E	HF Osc. Coil			SA: 6831							@ .31 and @ .50
F	HF Osc. Coil			SA: 6795							E Band, 900-2050KC
G	HF Osc. Coil			SA: 6785							F Band, 480-960KC
H	HF Osc. Coil			SA: 6805							G Band, 180-420KC
I	HF Osc. Coil			SA: 6811							H Band, 100-200KC
J	HF Osc. Coil			SA: 9249							I Band, 50-100KC
K	HF Osc. Coil			SA: 9235							AA Band, 27-30MC
L	HF Osc. Coil			SA: 9268							AB Band, 25-35MC
M	HF Osc. Coil			SA: 9267							AC Band, 21-21.5MC
L6	200KC IF Trans.	.90	.90	SA: 9205							AD Band, 50-54MC
L7	155KC Osc. Coil			SA: 9203							Includes .0001MFD cap. & 22KΩ resistor; tapped @ .11
L8A	2nd-IF Trans. Input	2.20	2.40	SA: 8448							Includes .0001MFD cap. & 22KΩ resistor; tapped @ .11
B	2nd-IF Trans. Input	2.20	2.40	SA: 6072							Part of L8A
L9	RF Choke	00		SA: 8448							1.1 Microhenries
L10A	3rd-IF Trans. input	2.20	2.40	SA: 6072							Part of L10A
B	3rd-IF Trans. Output	2.20	2.40	SA: 8448							1.1 Microhenries
L11	RF Choke	00		SA: 6072							Part of L10A
L12	4th-IF Trans.	2.40	2.50	SA: 3353							Includes 22KΩ resistor & 270MMF cap.; tapped @ .80
L13	BFO Coil	40		SA: 3353							Includes 22KΩ resistor & 270MMF cap.; tapped @ .80
L14	Speaker Output Choke	00		SA: 3392							1 Microhenry

Note 1. Some Models use .01MFD in this application

CONTROLS

ITEM No.	RATING		REPLACEMENT DATA					INSTALLATION NOTES
	RESIST- ANCE	WATTS	NATIONAL PART No.	IRC PART No.	CLAROSTAT PART No.	CENTRALAB PART No.	MALLOY PART No.	
R1	500KΩ	1	J681-2					Limiter & Switch
R2	5000Ω	2	K349-4					RF Gain-Wire Wound
R3A	500KΩ	1	K347-1	Q13-133	AG-60-Z	B-60-S	U-48	AF Gain
B	Shaft		Not Req.	Not Req.	RS-2	Not Req.	Not Req.	Attach to R3A
B	Switch		Not Req.	76-1	SWB	Not Req.	US-26	Attach to R3A
R4	500KΩ	1	K347-1	Q13-133	AG-60-Z	B-60-S	U-48	Tone
B	Shaft		Not Req.	Not Req.	RS-2	Not Req.	Not Req.	Attach to R4A
B	Switch		Not Req.	76-1	SWB	Not Req.	US-26	Attach to R4A
C	Switch		D831-2	W-100	A43-1000		RU000L	"S" Meter Adjustment
R5A	1000Ω	1	K83-2	Not Req.	FKS-1/4		Not Req.	Attach to R5A
B	Shaft		K915-13	W-25	A43-25		R25L	Dimmer
B	250	2	K915-13	W-25	A43-25		Not Req.	Attach to R6A
R6A	B		Not Req.	Not Req.	RS-2	Not Req.	Not Req.	

DISCUSSION

ITEM No.	RATING		REPLACEMENT DATA		NOTES
			NATIONAL PART No.	IRC PART No.	
	OHMS	WATT			
R7	470KΩ		J569-57	BTS-470K	
R8	100Ω		J569-13	BTS-100	
R9	47KΩ		J569-45	BTS-47K	
R10	470KΩ		J569-57	BTS-470K	
R11	560Ω		J569-22	BTS-560	
R12	100KΩ		J569-49	BTS-100K	
R13	100KΩ		J571-49	BTA-100K	
R14	22KΩ		J569-41	BTS-22K	
R15	22Ω		J569-5	BTS-22Ω	
R16	2200Ω		J569-29	BTS-2200	
R17	22KΩ		J569-41	BTS-22K	
R18	220Ω		J569-17	BTS-220	
R19	33KΩ		J571-43	BTS-33K	
R20	2200Ω		J569-29	BTS-2200	
R21	10KΩ		J569-49	BTS-10K	
R22	10KΩ		J569-37	BTS-10K	
R23	470KΩ		J569-57	BTS-470K	
R25	560Ω		J569-22	BTS-560	
R26	47KΩ		J569-45	BTS-47K	
R27	2200Ω		J569-29	BTS-2200	
R28	470KΩ		J569-57	BTS-470K	
R29	330Ω		J569-45	BTS-330K	
R30	2200Ω		J569-29	BTS-2200	
R31	470KΩ		J569-57	BTS-470K	
R32	470KΩ		J569-57	BTS-470K	
R33	150Ω		J569-15	BTS-150	
R34	47KΩ		J569-45	BTS-47K	
R35	2200Ω		J569-29	BTS-2200	
R36	100KΩ		J569-49	BTS-100K	
R37	220KΩ		J569-49	BTS-220K	
R38	100KΩ		J569-49	BTS-100K	
R39	1.5Meg		J569-83	BTS-1.5Meg	
R40	4.7Meg		J569-83	BTS-4.7Meg	
R41	4.7KΩ		J569-25	BTS-47K	
R42	1000Ω		J569-41	BTS-1000	
R43	22KΩ		J569-41	BTS-22K	
R44	470KΩ		J569-57	BTS-470K	
R45	220KΩ		J569-49	BTS-220K	
R46	220KΩ		J569-53	BTS-220K	

Parts list continued on next page.

PARTS LIST AND DESCRIPTIONS (Continued)

DIAL LIGHTS

ITEM No.	BASE TYPE	VOLTS	AMPS.	REPLACEMENT DATA		NOTES
				NATIONAL	PART No.	
M2	Bayonet	3-8	.15	Brown	F136-6	Type #47
M3	Bayonet	3-8	.15	Brown	F136-6	Type #47
M4	Bayonet	3-8	.15	Brown	F136-6	Type #47

MISCELLANEOUS

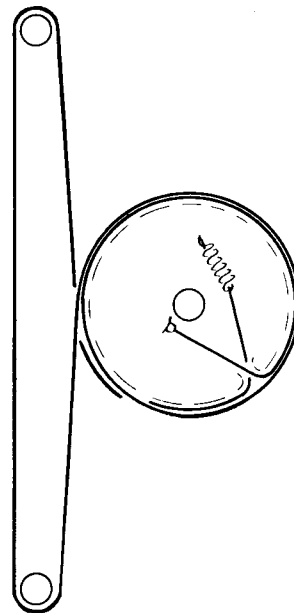
ITEM No.	PART NAME	NATIONAL PART No.	NOTES
M5	Tuning Capacitor	SA8667	Main (4 Sections)
M6	Tuning Capacitor	J957-31	Oscillator
M7	Tuning Capacitor	J957-32	Antenna
M8	Coil	SA9202	CW Osc. Adj.
M9	Trimmer	H500-6	IF Primary
	Capacitor	D825D-411	75MMF 500VDC
	Capacitor	D825C-301	25MMF 500VDC
	Trimmer Capacitor	D832-2	Mica Variable 3.5-35MMF
	Crystal	E979-1	455KC
	Capacitor	D825D-449	3MMF 500VDC
	Variable Capacitor	SA9190	Phasing Control
	Switch	E195-1	Selectivity
	Capacitor	D832-2	3.5-35MMF Mica
	Capacitor	D825D-426	10MMF 500VDC
M10	Capacitor	D825D-411	25MMF 500VDC
	Coil	SA9201	IF Output
	Resistor	J569-21	470Ω ½ watt
	Switch	E230-2	B+ On/Off
	Switch	E230-2	AVC
	Switch	P738-1	Calibrate
	Switch	SA6564	Function Selector
	Switch	R027-1	2nd. Conversion On/Off
	Switch	H340-4	T1 Primary Selector
	Meter	J984-5	Signal Meter 0-1MA with "S" scale
M11	Dial Scale	P136-15	Band "A"
	Dial Scale	P136-16	Band "B"
	Dial Scale	P136-3	Band "C"
	Dial Scale	P136-4	Band "D"
	Dial Scale	P136-17	Band "A" (Bandspread only)
	Dial Scale	P136-18	Band "B" (Bandspread only)
	Dial Scale	P136-7	Band "C" (Bandspread only)
	Dial Scale	P136-8	Band "D" (Bandspread only)
	Dial Scale	P136-9	Band "E" and "F"
	Dial Scale	P136-10	Band "G" and "H"
M12	Dial Scale	P136-11	Band "J"
	Dial Scale	P136-12	Band "AA"
	Dial Scale	P136-19	Band "AB"
	Dial Scale	P136-20	Band "AC"
	Dial Scale	P136-14	Band "AD"
	Dial Scale	P136-21	Band "AE"
	Knob	SA7021	Tone, antenna trimmer and dimmer controls (3 Used)
	Knob	SA6868	Crystal phasing and CW Osc. Controls (2 Used)
	Knob	SA6869	Selectivity Control
	Knob	SA6870	Limiter Control
M13	Knob	SA6871	AF Gain Control
	Knob	SA6867	RF Gain Control
	Knob	SA6586	Function Selector
	Knob	Q534-2	Main Tuning
	CW Osc. Shift		

RESISTANCE READINGS

Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
V 1	6BA6	3.5Meg 1500KΩ	100Ω	.1Ω	0Ω	1500Ω	150KΩ	100Ω	
V 2	6BA6	3.5Meg 1500KΩ	560Ω 600Ω	.1Ω	0Ω	1500Ω	100KΩ	560Ω 600Ω	
V 3	6C4	17.7KΩ	0Ω	1.8Ω	0Ω	17.7KΩ	22KΩ	0Ω	
V 4	6BE6	22KΩ	220Ω	1.8Ω	0Ω	11KΩ	135KΩ	.1Ω	
V 5	6BE6	22KΩ	.2Ω	0Ω	.1Ω	12.8KΩ	100KΩ	.1Ω	
V 6	6SG7	0Ω	0Ω	5600Ω 600Ω	3.5Meg 1500KΩ	5600Ω 600Ω	150KΩ	.1Ω	12.8KΩ
V 7	6SG7	0Ω	0Ω	5400Ω 400Ω	3.5Meg 1500KΩ	5400Ω 400Ω	150KΩ	.1Ω	13KΩ
V 8	6SG7	0Ω	0Ω	5200Ω 150Ω	3.5Meg 1500KΩ	5200Ω 150Ω	150KΩ	.1Ω	12.8KΩ
V 9	6SJ7	0Ω	0Ω	0Ω	22KΩ	.8Ω	100KΩ	.1Ω	1150KΩ
V 10	6H6	0Ω	0Ω	1.5Meg 1750KΩ	120KΩ	120KΩ	INF	1.8Ω	0Ω
V 11	6H6	0Ω	0Ω	1.1Meg 260KΩ	220KΩ 480KΩ	1.25Meg 470KΩ	1.6Meg 700KΩ	2Ω	220KΩ 480KΩ
V 12	6SJ7	0Ω	0Ω	2.4KΩ	25Ω	2.4KΩ	1600KΩ	.1Ω	150KΩ
V 13	6SN7GT	10Ω	150KΩ	1KΩ	270KΩ	150KΩ	52KΩ	0Ω	.1Ω
V 14	6V6GT	0Ω	0Ω	1180Ω	1300Ω	220KΩ	INF	.1Ω	213Ω
V 15	6V6GT	0Ω	0Ω	1160Ω	1300Ω	200KΩ	1160Ω	.1Ω	213Ω
V 16	5V4G	INF	100KΩ	INF	115Ω	INF	120Ω	INF	100KΩ
V 17	0B2	17KΩ	0Ω	INF	0Ω	17KΩ	154KΩ	0Ω	
V 18	4H-4	INF	.7Ω	INF	INF	INF	INF	1.5Ω	INF

FUNCTION SWITCH IN "AM" POSITION UNLESS NOTED
LIMITER IN "OFF" POSITION UNLESS NOTED
B+ SWITCH IN "ON" POSITION
CALIBRATE SWITCH IN "OFF" POSITION
AVC SWITCH IN "ON" POSITION UNLESS NOTED
RF GAIN CONTROL FULLY COUNTERCLOCKWISE UNLESS NOTED
† MEASURED FROM PIN 2 OF V16
‡ AVC SWITCH IN "CW" POSITION
§ AVC SWITCH IN "OFF" POSITION
* LIMITER SWITCH IN "ON" POSITION FULLY CLOCKWISE
■ RF GAIN CONTROL AT ZERO

TUNING GANG FULLY CLOSED



DIAL CORD DRIVE

ALIGNMENT INSTRUCTIONS

MAIN TUNING DIAL

The main tuning dial should normally give no trouble. If, however, the dial should become removed from the receiver it must not be operated until mounted on the capacitor shaft with set screws tight. This is because the dial is only designed to rotate for ten revolutions (0 to 500) and if turned farther than this the mechanism will be damaged. When mounted on the capacitor, limit stops protect the dial. The procedure for remounting the dial is as follows:

1. Place the dial on the capacitor shaft, tighten set screws and turn the dial counter clockwise to fully mesh capacitor rotor plates so that the tips of the rotor plates are flush with the edges of the stator plates.
 2. Loosen set screws and rotate dial slowly until the dial reading has decreased to zero.
 3. Tighten the set screws.
 4. Check position of rotor plates at zero. The tips of the rotor plates must be flush with the edge of the stator plates. A slight adjustment may be necessary and this is done by loosening the set screws, adjusting the position of the dial and tightening the set screws again.
- If it is necessary to remove the dial at any future time, turn to 250 before removing the dial and do not disturb the setting of either the dial or capacitor until reassembled. If in doubt about the correct position, inspect the springs on the back of the dial. When the dial reads 250 these springs should be straight up and down, they must not be tipped to one side.

It is important that the backplate and dial do not become separated. The backplate is held in place by two springs so that its gear teeth mesh with the dial gear teeth in correct relationship for proper dial operation. If this backplate should be sprung out of place, it may return to an incorrect position and the proper dial numbers will not appear in the windows when the dial is used. To ascertain that the two parts are in correct position proceed as follows:

1. Locate small window near outer periphery of dial backplate and also locate dial number window on face of dial which is 180 degrees removed from the small backplate window.
2. Hold dial so backplate lies flat in palm of left-hand and with right hand rotate dial knob until 250 appears in previously located dial window.
3. If dial is properly adjusted it will be noted that the pointer at the outer edge of the small window lines up with a marked tooth on the dial itself. It will be found that the dial and backplate can be moved so that the backplate pointer will mesh between teeth at points equidistant from marked tooth in either direction.
4. If by checking as in paragraph 3 the dial is found not properly adjusted, it will be necessary to separate the backplate from the dial far enough to bring the two gears out of mesh and the re-mesh the two parts until the proper setting is found. A number of trial settings may be required before the correct mesh is found.

SLIDE RULE TUNING DIAL

The slide-rule tuning dial assembly has been adjusted at the factory for accurate synchronization with the micrometer dial. If not tampered with this mechanism will provide complete freedom of mechanical trouble over a long period of continuous use. It is driven by an anti-backlash tuning gear ganged with the main tuning dial. The slide-rule dial pointer is controlled by a string drive assembly. If replacement of the string drive cord is required it will be necessary to remove the receiver chassis from its cabinet wraparound. Before removing the micrometer dial reference should be made to preceding paragraph for proper method of removal. Refer to the dial cord stringing diagram for the proper method of replacing the cord. After the cord has been replaced and before the receiver is returned to its cabinet the micrometer dial should temporarily be replaced and the slide-rule pointer correctly set in the following manner:

- (NOTE: This procedure may also be used if a check is desired to assure that the slide-rule dial pointer is properly synchronized with that of the main tuning dial.)
1. Check the main tuning dial at zero on its dial scale. The tips of the rotor plates should be flush with the edge of the stator plates.
 2. Set the Band Selector control so that the D coil set scale appears.
 3. Set the main tuning dial at 490 on its dial scale. Connect setting of the slide-rule dial pointer is 4 megacycles on the dial scale. Draw the slide rule pointer along the cord to its proper position being careful not to disturb the setting of the micrometer dial. After the correct setting has been obtained and use a small amount of glyptol or household cement to fasten the dial pointer securely in place on the cord.

ALIGNMENT INSTRUCTIONS

This receiver has been accurately calibrated by the manufacturer and is very stable. Realignment should not be necessary unless the receiver has been tampered with or unless component parts or tubes have been replaced. It is preferred that the individual aligning the receiver be one who is familiar with communication receivers and experienced with alignment there of.

To determine if IF Alignment is needed the following check should be performed:

1. Adjust the receiver for normal operation with the antenna disconnected.
2. Connect a pair of headphones to the phones jack.
3. Set the AVC switch at OFF.
4. Set the control switch to CW.
5. Set the phasing control at ZERO.
6. Set the crystal selectivity switch at "5".
7. Set the RF gain control at "10".

The AF gain control may be adjusted to a comfortable listening level and will not affect results.

Adjust the CWO control to a point where the predominate pitch of the background noise is lowest and a distinct ring of the crystal is heard. Note the setting of the CWO control.

Turn the crystal selectivity switch to OFF, and again adjust the CWO control for lowest pitch of background noise.

Compare this setting with the previous setting.

If the two settings are identical, the IF is properly aligned at the crystal frequency. If they are not identical perform IF amplifier alignment.

SECOND CONVERSION IF ALIGNMENT

The second conversion IF frequency of this receiver is 455KC plus or minus 2KC. The exact frequency is determined by the resonant frequency of the crystal in the crystal filter assembly.

Plug in the D range coil set.

Connect the high side of a signal generator output lead to the stator of the mixer section of the tuning gang. Connect the low side to the tuning gang frame.

Connect an output meter across the output terminals.

Set the control switch to CW.

Set the AVC switch to OFF.

Set the phasing control at ZERO.

Set the selectivity switch at "5".

Set the AF gain control at "10".

Set the RF gain control at "9".

Set the signal generator at approximately 455KC with the modulation off.

Set output of the generator to obtain approximately 100 microvolts.

Turn the CWO control to obtain a beat between 400 and 1000 cycles. The presence of the beat note may be checked by temporarily connecting a pair of phones to the phone jack. If difficulty is encountered in obtaining a beat note, adjust the BFO coil slug, A14.

Slowly vary the signal generator frequency between 453 and 457KC. Somewhere between these limits the output will show a sharp peaked increase, this is the frequency of the crystal, and the frequency to which the second conversion IF is aligned.

Turn the selectivity switch at "1".

Turn the control switch to "AM".

Turn the signal generator modulation ON.

	DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
1.	Direct	High side to stator on mixer section of tuning gang. Low side to tuning gang frame.	IF Crystal freq. (See note above) (400V-Mod)	Coil set "D".	Point of non-interference	Across output terminals.	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11	Adjust for maximum output. Attenuate signal generator to prevent overloading. The order of adjustment is not important.
2.	"	"	IF Crystal freq. plus 2KC.	"	"	"	A12	Adjust for maximum output.
3.	"	"	IF Crystal freq. (Same as step 1).	"	"	"	A13	"
4.	"	"	"	"	"	"	A14	Turn the selector switch to "CW". Adjust the CWO control to obtain zero beat. If zero beat does not occur at "0" on the CWO control knob, set knob at "0" and adjust A14 for zero beat.

NATIONAL
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FIRST CONVERSION CONVERTER ALIGNMENT

Leave the signal generator connected as during Second Conversion IF Alignment.
Set the control switch to AM.
Set the AVC switch to OFF.
Set the phasing control at ZERO.
Set the selectivity switch at OFF.
Set the AF gain control at "10".
Set the RF gain control at "9".
Plug in the "B" range coils.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
5. Direct	High side to stator of mixer section of tuning gang. Low side to frame of tuning gang.	2010KC (400vMod)	Coil set "B".	Point of non-interference.	Across output terminals.	A15	Adjust for a distinct peak on the output meter. If A15 is badly misadjusted more than one peak may be found. The correct peak will be of much higher amplitude than any of the spurious peaks.
6. "	"	"	"	"	"	A16, A17	Adjust for maximum output.

GENERAL COVERAGE OSC. & RF ALIGNMENT

The general coverage portion of this receiver has been properly aligned at the factory, using precision crystal controlled signal generators. Alignment should not be attempted unless proper precision equipment is available.
The need for realignment of the high frequency oscillator is indicated by the calibration being off more than 1% at the high frequency end of the dial scale.

Particular care must be exercised when adjusting the HF oscillator trimmer in each coil set. Three different checking procedures must be followed.

The coil sets below 7MC must be adjusted so the oscillator frequency is higher than the RF frequency. The image frequency should be 910KC below the signal frequency on the dial.

The oscillator for frequencies between 7MC and 35MC is set to the higher frequencies, but the image is 4020KC below the signal frequency. In some cases this frequency will be off the lower range of the coil set. In these cases special procedure must be used to check for the image.

In the 50MC to 54MC coil set, the oscillator must be adjusted to a frequency lower than the RF frequency.

The following methods should be used to ascertain that the oscillator is correctly adjusted on all coil sets:

1. When adjusting the oscillator in the coil sets below 7MC, the receiver should be tuned to a frequency 910KC below the RF frequency, at which point the image should appear. If it does not the oscillator trimmer should be decreased in capacity until the fundamental and image frequencies appear in correct positions on the dial.

2. When adjusting the oscillator on coil sets between 7MC and 35MC, the image must appear 4020KC below the RF frequency. In the cases where this frequency is beyond the range of the coil set, the receiver dial should be left at the proper frequency and the signal generator tuned to 4020KC above the RF frequency. It may be necessary to increase the generator output considerably to receive the image. The image must appear at the present dial position for proper oscillator tracking.

3. The oscillator for the AD coil set must be adjusted to the low frequency side of the RF signal. In this instance the image must be located 4020KC above the RF frequency. Leave the receiver tuned to the RF frequency and tune the generator 4020KC lower than the RF frequency. It may be necessary to increase the generator output to obtain the image. If the image is not present at this point the oscillator is not correctly adjusted.

Set the control switch to AM.

Set the AVC switch to OFF.

Set the RF gain control to "10".

Set the bandspread switches to general coverage.

Set the AF gain control to provide a suitable output level.

Check the position of the antenna trimmer and oscillator trimmer knobs. They should be set with the arrow pointing straight up.

Correction of tracking errors in the RF and mixer stages at the low frequency end of each coil set is accomplished by adjustment listed in the table. The actual tracking may be checked by pressing the end plates of the tuning gang sections either closer or away from the adjacent plate (do not bend plate enough so that it will not spring back to its original position). A change in capacity in either direction should decrease the output.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
7. 270Ω Carbon Resistors	High side thru 270Ω to antenna terminal. Low side to chassis.	30MC (400vMod)	Plug in coil set "A".	30MC	Across voice coil.	A18 (pos 8) A19 (pos 6) A20 (pos 4)	Adjust in order given for maximum output.
8. "	"	14.4MC	"	14.4MC	"	A21 (pos 16) A22 (pos 13) A23 (pos 11) A24 (pos 9)	Adjust in order given for max. output. Repeat steps 1 & 2 until no further improvement can be made.
9. "	"	14.4MC	Plug in coil set "B".	14.4MC	"	A25 (pos 8) A26 (pos 6) A27 (pos 4) A28 (pos 2)	Adjust in order given for maximum output.
10. "	"	7.0MC	"	7.0MC	"	A29 (pos 16) A30 (pos 13) A31 (pos 11) A32 (pos 9)	Adjust in order given for max. output. Repeat steps 9 & 10 until no further improvement can be made.
11. "	"	7.3MC	Plug in coil set "C".	7.3MC	"	A33 (pos 8) A34 (pos 6) A35 (pos 4) A36 (pos 2)	Adjust in order given for max. output.
12. "	"	3.5MC	"	3.5MC	"	A37 (pos 16) A38 (pos 13) A39 (pos 11) A40 (pos 9)	Adjust in order given for max. output. Repeat steps 11 & 12 until no further improvement can be made.
13. "	"	1.8MC	Plug in coil set "D".	1.8MC	"	A41 (pos 8) A42 (pos 6) A43 (pos 4)	Adjust in order given for max. output.
14. "	"	4.0MC	"	4.0MC	"	A44 (pos 16) A45 (pos 13) A46 (pos 11) A47 (pos 12)	Adjust in order given for max. output. Repeat steps 13 & 14 until no further improvement can be made.
15. "	"	2.0MC	Plug in coil set "E".	2.0MC	"	A48 (pos 8) A49 (pos 6) A50 (pos 4)	Adjust in order given for max. output.
16. "	"	1 MC	"	1 MC	"	A51 (pos 7)	Adjust for max. output.
17. "	"	1.4MC	"	1.4MC	"	A52 (pos 16)	Adjust for max output. Repeat steps 15, 16 & 17 until no further improvement can be made.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.
18. "	"	.9MC	Plug in coil set "F".
19. "	"	.5MC	"
20. "	"	.7MC	"
21. "	"	400KC	Plug in coil set "G".
22. "	"	200KC	"
23. "	"	300KC	"
24. "	"	200KC	Plug in coil set "H".
25. "	"	100KC	"
26. "	"	150KC	"
27. "	"	100KC	Plug in coil set "J".
28. "	"	50KC	"
29. "	"	75KC	"
30. "	"	30MC	Plug in coil set "AA".
31. "	"	27.2MC	"
32. "	"	28MC	"
33. "	"	35MC	Plug in coil set "AB".
34. "	"	25MC	"
35. "	"	30MC	"
36. "	"	21.5MC	Plug in coil set "AC".
37. "	"	21MC	"
38. "	"	21.3MC	"
39. "	"	54MC	Plug in coil set "AD".
40. "	"	50MC	"
41. "	"	52MC	"

CTIONS (CONT.)

IO L NG	OUTPUT METER	ADJUST	REMARKS
	"	A53 (pos. 8) A54 (pos. 6) A55 (pos. 4) A56 (pos. 2)	Adjust in order given for max. output.
	"	A57 (pos. 7)	Adjust for max. output.
	"	A58 (pos. 16)	Repeat steps 18, 19, & 20 until no further improvement can be made.
	"	A59 (pos. 8) A60 (pos. 6) A61 (pos. 4)	Adjust in order given for max. output.
	"	A62 (pos. 7)	Adjust for max. output.
	"	A63 (pos. 16)	Adjust for max. output. Repeat steps 21, 22 & 23 until no further improvement can be made.
	"	A64 (pos. 8) A65 (pos. 6) A66 (pos. 4) A67 (pos. 2)	Adjust in order given for max. output.
	"	A68 (pos. 8)	Adjust for max. output.
	"	A69 (pos. 16)	Adjust for max. output. Repeat steps 24, 25, & 26 until no further improvement can be made.
	"	A70 (pos. 8) A71 (pos. 6) A72 (pos. 4) A73 (pos. 2)	Adjust in order given for max. output.
	"	A74 (pos. 7)	Adjust for max. output.
	"	A75 (pos. 16)	Adjust for max. output. Repeat steps 27, 28, & 29 until no further improvement can be made.
	"	A76 (pos. 7) A77 (pos. 5) A78 (pos. 3) A79 (pos. 1)	Adjust in order given for maximum output.
	"	A80 (pos. 8) A81 (pos. 6) A82 (pos. 4) A83 (pos. 2)	"
	"	A84 (pos. 16) A85 (pos. 13) A86 (pos. 11) A87 (pos. 9)	Adjust in order given for maximum output. Repeat steps 30, 31 and 32 until no further improvement can be made.
	"	A88 (pos. 8) A89 (pos. 6) A90 (pos. 4) A91 (pos. 2)	Adjust in order given for maximum output.
	"	A92 (pos. 7) A93 (pos. 5) A94 (pos. 3) A95 (pos. 1)	"
	"	A96 (pos. 16) A97 (pos. 13) A98 (pos. 11) A99 (pos. 9)	Adjust in order given for maximum output. Repeat steps 33, 34 and 35 until no further improvement can be made.
	"	A100 (pos. 7) A101 (pos. 6) A102 (pos. 4) A103 (pos. 2)	Adjust in order given for maximum output.
	"	A104 (pos. 6) A105 (pos. 5) A106 (pos. 3) A107 (pos. 1)	"
	"	A108 (pos. 16) A109 (pos. 13) A110 (pos. 11) A111 (pos. 9)	Adjust in order given for maximum output. Repeat steps 36, 37 and 38 until no further improvement can be made.
	"	A112 (pos. 7) A113 (pos. 5) A114 (pos. 3) A115 (pos. 1)	Adjust in order given for maximum output.
	"	A116 (pos. 8) A117 (pos. 6) A118 (pos. 4) A119 (pos. 2)	"
	"	A120 (pos. 16) A121 (pos. 13) A122 (pos. 11) A123 (pos. 9)	Adjust in order given for maximum output. Repeat steps 39, 40 and 41 until no further improvement can be made.

BAND SPREAD OSC. & RF ALIGNMENT

It is important that general coverage alignment be performed before bandspread alignment, since general coverage alignment affects bandspread alignment. General coverage alignment is not affected by bandspread alignment, so if only bandspread alignment is required it may be performed separately. The need for oscillator alignment of any band is indicated by the main tuning dial being off more than 5 divisions in either direction. The pre-alignment settings of the receiver controls are the same as for general coverage alignment, EXCEPT, that the bandspread switch on each coil set must be switched to **BANDSPREAD**. The low frequency tracking may be checked by making a slight adjustment of the trimmer capacitors at positions 1, 3 and 5. A slight change in either direction should decrease the output. The trimmers should be reset at the high frequency end of each band.

DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	BAND SWITCH POS.	RADIO DIAL SETTING	OUTPUT METER	ADJUST	REMARKS
42. 270Ω Carbon Resistor	High side thru 270Ω to antenna terminal. Low side to chassis.	30MC (400%Mod)	Plug in Coil Set "A"	30MC	Across out- put terminals	A124 (pos. 7) A125 (pos. 5) A126 (pos. 3) A127 (pos. 1)	Adjust in order given for maximum output.
43. "	"	27.2MC	"	27.2MC	"	A128 (pos. 15) A129 (pos. 14) A130 (pos. 12) A131 (pos. 10)	Adjust in order given for maximum output. Repeat steps 42 and 43 until no further improvement can be made.
44. "	"	14.4MC	Plug in Coil Set "B"	14.4MC	"	A132 (pos. 7) A133 (pos. 5) A134 (pos. 3) A135 (pos. 1)	Adjust in order given for maximum output.
45. "	"	14MC	"	14MC	"	A136 (pos. 15) A137 (pos. 14) A138 (pos. 12) A139 (pos. 10)	Adjust in order given for maximum output. Repeat steps 44 and 45 until no further improvement can be made.
46. "	"	7.3MC	Plug in Coil Set "C"	7.3MC	"	A140 (pos. 7) A141 (pos. 5) A142 (pos. 3) A143 (pos. 1)	Adjust in order given for maximum output.
47. "	"	7.0MC	"	7.0MC	"	A144 (pos. 15) A145 (pos. 14) A146 (pos. 12) A147 (pos. 10)	Adjust in order given for maximum output. Repeat steps 46 and 47 until no further improvement can be made.
48. "	"	4.0MC	Plug in coil set "D"	4.0MC	"	A148 (pos. 7) A149 (pos. 5) A150 (pos. 3) A151 (pos. 1)	Adjust in order given for maximum output.
49. "	"	3.5MC	"	3.5MC	"	A152 (pos. 15) A153 (pos. 14) A154 (pos. 12) A155 (pos. 10)	Adjust in order given for maximum output. Repeat steps 48 and 49 until no further improvement can be made.

FIRST RF STAGE ALIGNMENT WITH LOW IMPEDANCE TRANSMISSION LINE

If a low impedance transmission line is used with this receiver, it may be necessary to align the 1st. RF Amplifier at the high frequency end of each band. To check for this possibility rotate the antenna trimmer control. The presence of two distinct peaks in output indicate that the RF Amplifier is tracking properly. Lack of a peak or presence of only one peak indicates improper tracking and need for correction.

GENERAL COVERAGE ADJUSTMENTS

Set the band spread switches on each coil set to be aligned to general coverage.
Set the control switch to **AM**.
Set the selectivity switch at **OFF**.
Set antenna trimmer control knobs so the arrow points straight up towards top of set.
Set the **AF** gain control at "10".
Set the RF gain to a suitable listening volume.
Coil sets A, D, E and G do not use a 1st. RF Amplifier general coverage trimmer, but are peaked by the antenna trimmer control over the full range of the coil set.
Connect the antenna feeders to the receiver antenna terminals and tune the receiver to the signal frequency first shown in the general coverage Osc. & RF Alignment table for each coil set (Coil set "A", 30MC, coil set "B", 7MC, etc.).
Peak trimmers as follows for maximum signal, or if no signal is available, for maximum background noise.

Coil Set A	Adjust Ant. Trimmer Control
Coil Set B	Adjust A27 (pos. 4)
Coil Set C	Adjust A34 (pos. 4)
Coil Set D	Adjust Ant. Trimmer Control
Coil Set E	Adjust Ant. Trimmer Control
Coil Set F	Adjust A54 (pos. 2)
Coil Set G	Adjust Ant. Trimmer Control
Coil Set H	Adjust A65 (pos. 2)
Coil Set J	Adjust A71 (pos. 2)
Coil Set AA	Adjust A77 (pos. 1)
Coil Set AB	Adjust A89 (pos. 2)
Coil Set AC	Adjust A101 (pos. 2)

BANDSPREAD ADJUSTMENTS

Set the bandspread switches on each coil set to be aligned to bandspread position.
Set the receiver controls in the same manner as general coverage.
Connect the antenna feeders to the receiver antenna terminals, and tune to the signal frequency first shown on the bandspread Osc. & RF adjustment table for each coil set.
Peak the trimmers as follows for maximum signal, or if no signal is available for maximum background noise.

Coil Set A	Adjust A125 (pos. 1)
Coil Set B	Adjust A133 (pos. 1)
Coil Set C	Adjust A141 (pos. 1)
Coil Set D	Adjust A149 (pos. 1)

S-METER ADJUSTMENT

The "S" meter balancing resistor R5 is used to obtain zero meter reading in the absence of signal.
Set the RF gain control at "0".
Set the AVC switch to **AVC**.
Set the control switch to **AM**.
Adjust R5 until "S" meter reads zero.

PARTS LIST AND DESCRIPTIONS

TUBES (SYLVANIA or Equivalent)

ITEM No.	USE	REPLACEMENT DATA		RTMA BASE TYPE	NOTES
		NATIONAL PART No.	STANDARD REPLACEMENT		
V1	1st RF Amplifier	6BA6	6BA6	TBK	
V2	2nd RF Amplifier	6BA6	6BA6	TBK	
V3	H.F. Oscillator	6C4	6C4	6BG	
V4	Mixer	6BE6	6BE6	7CH	
V5	Converter	6BE6	6BE6	8BK	
V6	1st IF Amplifier	6SG7	6SG7	8BK	
V7	2nd IF Amplifier	6SG7	6SG7	8BK	
V8	3rd IF Amplifier	6SG7	6SG7	8BK	
V9	C.W. Oscillator	6H6	6H6	8N	
V10	Detector-AVC	6H6	6H6	8N	
V11	Noise Limiter	6H6	6H6	8N	
V12	AF Amplifier	6H6	6H6	8N	
V13	Phase Inverter	6H6	6H6	8N	
V14	"S" Meter Amp.	6H6	6H6	8N	
V15	Audio Output	6H6	6H6	8N	
V16	Rectifier	5V4G	5V4G	5L	
V17	Voltage Reg.	OB2	OB2	4H-4	
V18	Current Reg.	4H-4	4H-4	4H-4	

CAPACITORS

Capacity values given in the rating column are in mfd. for Electrolytic and Paper Capacitors, and in mmfd. for Mica and Ceramic Capacitors.

ITEM No.	RATING CAP. VOLT	REPLACEMENT DATA				NOTE
		NATIONAL PART No.	AEROVOX PART No.	CORNEILL-DUBILIER PART No.	ERIE PART No.	
C1A	40	K945-3	APR2-72	BO53	FP262	TVL-2830
C2	40	E338-4	PR550/25	BR255A	TC36	TVA-1306
C3	25	E338-4	PR550/25	BR255A	TC36	TVA-1306
C4	25	E338-4	PR550/25	BR255A	TC36	TVA-1306
C5	10000	K946-2	BPD-01	TM581	DC-311	5HK-SI
C6	1	1217-35	1494-01	PTE4P1	MC475	4TM-P1
C7	5000	K946-1	BPD-005	TM5D5	DC-525	5HK-D5
C8	500	1217-29	P488-05	PTE4S5	PT415	4TM-S5
C9	500	1217-29	P488-05	PTE4S5	PT415	4TM-S5
C10	500	1217-29	P488-05	PTE4S5	PT415	4TM-S5
C11	5000	K946-1	BPD-005	TM5D5	DC-525	5HK-D5
C12	5000	K946-1	BPD-005	TM5D5	DC-525	5HK-D5
C13	5000	K946-1	BPD-005	TM5D5	DC-525	5HK-D5
C14	500	1217-29	P488-05	PTE4S5	PT415	4TM-S5
C15	500	1217-29	P488-05	PTE4S5	PT415	4TM-S5
C16	5000	K946-1	BPD-005	TM5D5	DC-525	5HK-D5
C17	10000	K946-2	1497-01	MC475	MC475	4TM-P1
C18	400	1217-35	P488-1	PTE4P1	PT401	5GA-TI
C19	100	D825C-304	SIU00	TM5T1	UC-531	5TCCB-V47
C20	5	D825D-401	SIU0P0	TM5T1	2T-555	5TCCB-V47
C21	10	D825D-402	SIU0P0	TM5T1	2T-555	5TCCB-V47
C22	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C23	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C24	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C25	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C26	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C27	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C28	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C29	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C30	1000	K375-4	SIU000	TM5D1	UC-521	5HK-D1
C31	1000	K375-4	SIU000	TM5D1	UC-521	5HK-D1
C32	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C33	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C34	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C35	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C36	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C37	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C38	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI
C39	25	1217-48	P288-25	TM5D1	UC-521	5HK-D1
C40	100	D825D-421	SIU00	TM5T1	UC-531	5GA-TI
C41	10000	K946-2	BPD-01	TM581	DC-511	5HK-SI

PARTS LIST AND DESCRIPTIONS (Continued)

RESISTORS (CONT.)

ITEM No.	RATING OHMS	WATT	REPLACEMENT DATA		NOTES
			NATIONAL PART No.	IRC PART No.	
R47	220KΩ	1/2	1569-53	BTS-220K	
R48	470KΩ	1/2	1569-57	BTS-470K	
R49	220KΩ	1/2	1569-53	BTS-220K	
R50	220KΩ	1/2	1569-53	BTS-220K	
R51	220KΩ	1/2	1569-53	BTS-220K	
R52	150Ω	1/2	1569-15	BTS-150	
R53	470KΩ	1/2	1569-57	BTS-470K	
R54	100KΩ	1/2	1569-49	BTS-100K	
R55	47KΩ	1/2	1569-45	BTS-47K	
R56	6800Ω	1/2	1569-35	BTS-6800	
R57	220KΩ	1/2	1569-53	BTS-220K	
R58	470KΩ	1/2	1569-57	BTS-470K	
R59	470KΩ	1/2	1569-53	BTS-470K	

Note 1. May be from 100Ω to 1000Ω. Individually chosen to meet the requirements of each receiver.
Note 2. Some Models use a 150Ω resistor in this application.

TRANSFORMER (POWER)

ITEM No.	RATING				REPLACEMENT DATA			
	PRI.	SEC. 1	SEC. 2	SEC. 3	NATIONAL PART No.	STANCOR PART No.	CHICAGO PART No.	TRIAD PART No.
T1	117VAC ② 1A with tap for 230VAC	550VCT .130ADC ③ 3A	5VAC ④ 4.6A	6.3VAC ⑤ 4.6A	SA9209			

TRANSFORMER (AUDIO OUTPUT)

ITEM No.	RATING				REPLACEMENT DATA			
	IMPEDANCE	DC RES.	SEC.	SEC.	NATIONAL PART No.	STANCOR PART No.	CHICAGO PART No.	TRIAD PART No.
T2	8.2KΩ Tap @ 8Ω	312ΩCT Tap @ 8Ω	P187-1					

FILTER CHOKE

ITEM No.	BATINGS		REPLACEMENT DATA	
	TOTAL DIRECT CURRENT	D. C. RESISTANCE	INDUCTANCE (0 CURRENT 1000 CY)	17HY
L1	.065A	290Ω	SA1694	

COILS (RF-IF)

ITEM No.	USE	DC RES.		REPLACEMENT DATA		NOTES
		PRI.	SEC.	NATIONAL PART No.	MILLER PART No.	
L2A	Ant. Trans.	2Ω	0Ω	SA-8363		A Band, 14-30MC
B	Ant. Trans.	3Ω	2Ω	SA-8755		B Band, 7-14.4MC
C	Ant. Trans.	3Ω	2Ω	SA-8759		C Band, 3.5-7.3MC
D	Ant. Trans.	.5Ω	.7Ω	SA-8635		D Band, 1.7-4MC
E	Ant. Trans.			SA-8513		E Band, 900-2050KC
F	Ant. Trans.			SA-8680		F Band, 480-960KC
G	Ant. Trans.			SA-8685		G Band, 180-420KC
H	Ant. Trans.			SA-8903		H Band, 100-200KC
I	Ant. Trans.			SA-8908		I Band, 50-100KC
J	Ant. Trans.			SA-8614		AA Band, 27-30MC
K	Ant. Trans.			SA-8673		AB Band, 95-35MC
L	Ant. Trans.			SA-8073		AC Band, 21-21.5MC
M	Ant. Trans.			SA-9261		AD Band, 50-54MC